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Smoother sailing ahead : integrating information technology into the surface Navy

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Smoother Sailing Ahead: Integrating Information Technology into the Surface Navy

by

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ABSTRACT

Organizations incorporate changes in technological capabilities and patterns of work slowly and with great difficulty. Similar to the introduction of electricity in the early 1990s, information technology's benefits were not realized until competition forced private companies to adapt their organizational structure and operating practices to take advantage of new capabilities. They sought to change the very nature of work, not just do work faster.

A decreasing defense budget forces the Navy to face many of the common problems overcome earlier in the world of private industry. This initial exploration identifies potential opportunities to be gained by taking a business perspective in the integration of information technology in the evolution to smaller, more capable, less manpower-intensive surface ships.

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I. THE INTEGRATION OF INFORMATION TECHNOLOGY

Many of the productivity gains achieved in private industry during the past decade continue to elude the Navy's surface fleet. Commercial organizations have been forced by competition to integrate information technology (IT) into the business process, thereby reducing the work force while increasing productivity. Faced with increasing international commitments, a decreasing defense budget and a smaller surface fleet, the Navy must take a business perspective in integrating information technology in the evolution to smaller, more capable, less manpower-intensive surface ships.

A. INFORMATION TECHNOLOGY IN PRIVATE INDUSTRY

Private companies solve modern problems using information technology however and wherever profitable. Through organization redesign, human resource policies and the growing capabilities of IT, they reengineer to compete--effectively reaping the benefits of new capabilities in information technology.

B. INFORMATION TECHNOLOGY IN THE NAVY

The military also uses new technology throughout the services, but with less dramatic results. The procurement and support of IT systems make up the largest item in the capital spending budget of the Department of Defense: 9.8 billion dollars in the 1993 budget allocation. The Navy invested much of this money in the installation of computer systems on ships, to perform functions that the crew had previously performed. However, the Navy has not yet taken full advantage of the capabilities these new technologies provide, largely because it contracted for systems designed to fit the existing surface fleet's organizational structure, operating procedures and practices. System development methodologies did not challenge many existing practices, particularly on surface ships. While they automated many manual procedures, they failed to reduce the number of onboard personnel.

The designers and developers of new ships and of ship systems personnel largely overlooked the broad view of a surface ship's mission--and the factors leading to successful mission accomplishment--as related to potential information technology systems. In the absence of this broader perspective, the new systems they adopted simply rivet into place the long-established methods of conducting operations, making change ever more difficult.

C. THE INFLUENCE OF COMPETITION

Why has productivity improved and the number of employees been cut so drastically in private industry (especially shipping), while the Defense Department allocates such a large percentage of its annual budget to IT without the same degree of cost savings in manpower? One factor influencing this phenomenon may be competition. Fierce domestic and growing international competition force manufacturers to change their organizational structures and work procedures in order to achieve the highest quality output for any given input, with little room for poor performance, quality, or productivity.

As capabilities of information technology grew, the private sector drastically altered the way information system employees worked.

D. PRIVATE INDUSTRY'S EARLY PROBLEMS

The benefits of using new technologies at first evaded even the most progressive companies. Many simply bought new systems, cut the payroll and loaded the work on the survivors. (Levinson, 1994 p. 49) Modern downsizing dramatically differs from the slash-and-burn tactics of the 1970s and 1980s. Companies are "combing their businesses from top to bottom to eliminate tasks and procedures that don't bring profit." (Levinson, 1994, p. 49)

Researchers found a parallel in the productivity slump that occurred in the early part of this century. By 1919 most U. S. factories had moved from steam to electricity, yet productivity had not improved since the 1890s.

> New electric equipment was installed at a rapid pace, but it typically just replaced older machines in the existing, formerly steam-driven factories with their old and inefficient layouts. Productivity soon jumped, however, as businesses built new factories and redesigned their shop floor layouts and work steps to take advantage of electricity and electric motors.
>
> (Schnitt, 1993, p. 16)

Those organizational and process changes greatly improved efficiency and effectiveness. Similarly, today's companies use computers and new information systems to change the very nature of work, not just to do work faster.

In the move to larger, electrically-powered manufacturing during the early 1900s, private industry adopted a hierarchical organizational structure similar to those used by the military. They called their adapted version "scientific management." These larger companies stressed management over the many by the few through efficiency and control. Managers designed tasks to the lowest level of skill possible. Engineers and consultants conducted time-and-motion studies, determining the time allowed for each task and the steps needed to complete it. A growing bureaucratic hierarchy took information from the workers, sending it up and down the chain of command through departments organized functionally. Layers of management summarized work progress and performance factors, sending these reports higher up the chain until they reached decision makers. Top managers made decisions, communicating them down the hierarchy to the lowest level for implementation. In 1994--nearly a century later--surface ships continue to use the same method, as they have for centuries.

E. REVOLUTIONARY CHANGES IN PRIVATE INDUSTRY

As technology changed and more efficient means of coordination emerged, competition forced private companies to examine their business and management processes and adopt new ones that improved efficiency--or go out of business. "American manufacturers in the 1970s and 1980s woke up to increased competition from abroad." (Schnitt, 1993, p. 17) They found themselves deficient in the competition for quality, customer service, speed, innovation and cost. Their competitors produced goods faster, cheaper and of better quality, often employing fewer people for the same amount of work. (Schnitt, 1993, p. 18)

Private companies modified the way they did business in order to survive radical change. With a new perspective they began examining their business processes, moving away from separate departments and multiple layers of management. For example, faced with huge operating losses and intense foreign competition, Ford Motor Company examined many areas of its operations. In its supply procurement division Ford employed over 500 personnel, generating reams of paperwork that contained many inventory discrepancies and billing errors. Mazda Motors in Japan performed the same function better with five employees. (Schnitt, 1993, p. 19) The competition forced Ford to adopt new methods using modern information technology. Instead of pieces of information moving through different departments, the supply personnel entered the invoice once, with verification performed by the workers receiving the supplies. By reengineering the process Ford reduced the division's personnel by 75%, while dramatically improving the speed, cost and quality of the process. (Schnitt, 1993, p. 19)

Companies found that work performed by different people as a series of separate steps led to poor quality, an absence of accountability and employees' inability to sense the big picture and overall goals of the organization. Comparing themselves to the competition, these old-style companies realized their relatively poor performance. With customers demanding better products and services, many companies reengineered.

"Reengineering can be defined as the reorganization of the organization, its way of conducting business and its information technologies to attain better overall performance." (Sprague and McNurlin, 1993, p. 82) The process of business reengineering involves redesigning work to capitalize on the technical and employee changes evolving since the days of scientific management. Today's work force contains a higher percentage of well trained, educated employees who are knowledgeable and experienced enough to perform their work and make decisions traditionally reserved for higher- level management. The evolution in information technology allows multiple users instant access to information and cooperation with others in ongoing work without the coordination of upper management.

F. DOLLARS DICTATE CHANGE IN THE SURFACE FLEET

> The way we generally operate our organization is by cloning. Now if you clone, you can't change and can't adapt. Today we don't need clones. We need change.
> (VADM Kalleres, 1994)

The leadership of the Navy's surface fleet doesn't need to look far to see the need for change. With a decreasing Defense budget and its impact throughout the military, new approaches are being undertaken to provide for the nation's defense at a lower cost without decreasing readiness. By 1999, the Navy plans to reduce active-duty forces by 170,000 enlisted and 20,000 officers, while cutting up to 185 surface ships compared to the Navy of 1989. (Force 2001, 1993, p. 37) William Kaufmann, a respected military analyst at the Brookings Institution, believes the 1993 military budget of $276 billion could drop as low as $182 billion in 1993-adjusted dollars by 1997. (Ratan, 1993, p. 92)

G. A KEY FEATURE OF THE NAVY'S COST REDUCTION PLANS

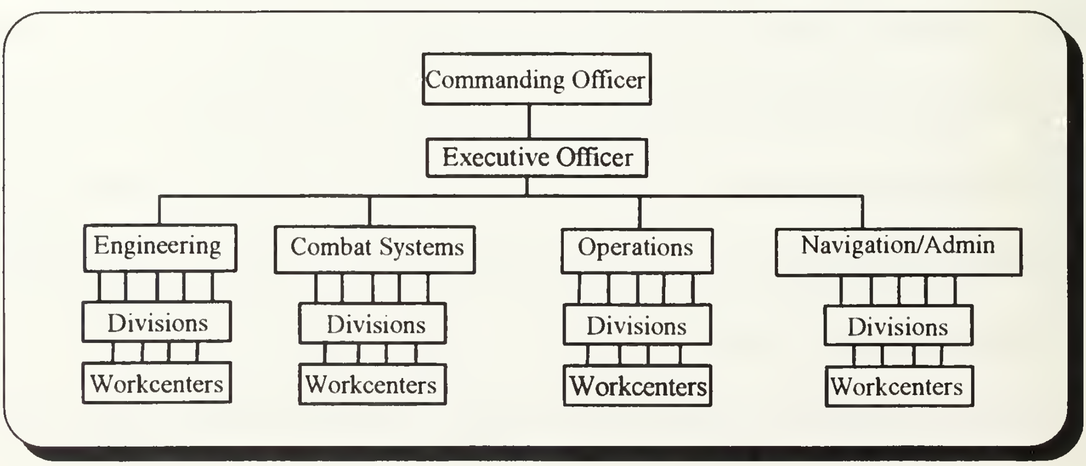
All of the leading cost-reduction plans being considered share a common feature: the reduction in active-duty ships is being offset by an increase in Military Sealift Command vessels. The increases proposed go as high as 61 vessels by 1997; there are 33 in service today. (Ratan, 1993, p. 93) The reason for replacing active-duty ships with primarily civilian-manned ones is simple: These ships provide nearly the same capability in sealift, resupply and refueling at a greatly reduced cost. The Military Sealift Command *integrated* information technology into their ship operations and *changed* their organizational structure to take advantage of the new capabilities. Not unlike the American auto industry of the 1980s, this part of the surface Navy is being replaced by a lower cost and better service provider.

II. YESTERDAY'S FLEET CAN'T COMPETE: TRADITIONAL MANAGEMENT ORGANIZATION OF A U. S. NAVY SURFACE SHIP

A. ORIGINS OF THE ORGANIZATION

One reason why the Navy's surface fleet is no longer competitive in meeting service needs lies in the continued use of an outmoded organizational structure. The roots of the current surface ship's organizational structure stretch back over two hundred and fifty years, to the British navy and the age of the Industrial Revolution. Inefficiency and ineffectiveness arise from applying ancient, sail and mechanical-age principles to the new possibilities provided by Information Age technologies.

The command and control structure of Navy surface ships today resembles those of manufacturing firms in the first half of the twentieth century. A Commanding Officer, with the assistance of an Executive Officer, heads the organization which is made up of officer and enlisted specialists broken into different departments, divisions, and work centers. Each functional unit works for and reports to superiors in a hierarchical structure.



Standard Surface Ship Organizational Structure

Figure 1 (OPNAVINST 3120.32B, 1986, p. 2-3)

> This organizational structure is no longer the most appropriate . . . Self-managed groups provide much of their own management, have lower absenteeism, higher yield productivity, produce higher quality work, and are more motivated than workers in traditional settings.
>
> (Sprague and McNurlin, 1993, p. 13)

B. SHIP CONTROL AND NAVIGATION

The center of an underway surface ship's command and control structure during peacetime steaming is the *Officer of the Deck*. OPNAVINST 3120.32B lists this officer's eighteen primary duties during the normal four-hour watch process (OPNAVINST 3120.32B, 1986, pp. 4-16 to 4-19). The Officer of the Deck reports to as many as seven superior officers during the watch: the Commanding Officer, Executive Officer, Command Duty Officer, Navigator, Tactical Action Officer, and any embarked Commander and that Commander's Staff Watch Officer. Approximately 60 junior personnel report indirectly to the Officer of the Deck through the six primary personnel who report directly: the Junior Officer of the Deck, Junior Officer of the Watch, Combat Information Center Watch Officer, Damage Control Watch Officer, Communications Watch Officer and the Engineering Officer of the Watch.

The hierarchical operating procedures are described on the following pages. With a hierarchical organizational structure, the more important the information the further down in the organization a person must go to get it. For example: If the roving Sounding and Security Watch detected flooding in number one pump room (a normally unmanned space), he or she would make this flooding report to the Damage Control Watch in Damage Control (DC) Central. This watch stander would take the information and relay it to the bridge over the 1JV sound-powered phone circuit monitored by the Lee Helmsman. The Lee Helmsman would make this report to the Junior Officer of the Deck to relay to the Officer of the Deck for possible corrective action.

Similar communication channels transfer the status of engineering and auxiliary equipment, fires, sighting of air and surface contacts, electronic emission detection, personnel casualties, sonar contacts, incoming voice, visual and electronic communications and a host of other information needed by the Officer of the Deck. The multiple levels these communications transfer through leaves open the possibility and even probability that critical information could be altered, misinterpreted, or not even make it through the complete path up the chain of command.

To assist the Officer of the Deck on the bridge, the Ship's Organization and Regulations Manual (SORM) provides a host of officer and enlisted watch standers to perform various functions and relay needed information. The number of bridge watch standers almost doubles during General Quarters, but during normal peacetime steaming it consists of 12 watch standers.

A *Junior Officer of the Deck* (JOOD) principally assists the OOD in the performance of his or her duties. Normally filled by newly reported junior officers, this watch stander becomes familiar with the duties and responsibilities of the OOD in order to later qualify for that position. On most ships, the JOOD also serves as the Conning Officer, giving the rudder and steering orders to the Helmsman and engine orders to the Lee Helmsman.

A *Junior Officer of the Watch* (JOOW) also becomes familiar with bridge operation to later qualify as OOD. He or she primarily monitors any guarded bridge tactical communication circuits, responds to ones directed to the ship and encrypts and decrypts coded messages with various code books. The JOOW also plots surface contacts to determine their course, speed, and closest point of approach to the ship, and determines relative and true wind direction and speed for helicopter operations.

The *Quartermaster of the Watch* (QMOW) performs routine navigation duties, plotting the ship's position, course and speed as well as monitoring environmental conditions. As a qualified helmsman, the QMOW also assists in that watch station's training and supervision. He or she documents events in the ship's deck log and executes the ceremonial sunset and sunrise duties.

The *Boatswain's Mate of the Watch* (BMOW) supervises the bridge enlisted-watch standers--with the exception of the QMOW, who is supervised by the Navigator. The BMOW announces the daily routine from reveille to taps over the ship's 1MC communications circuit, and assists the OOD in carrying out the ship's daily routine.

The *Helmsman*, normally a very junior enlisted seaman, steers the ship on the heading and course ordered by the conning officer and continually monitors the difference between the ship's gyro heading and magnetic heading in case of loss of the ship's gyrocompass.

The *Lee Helmsman* transmits engine orders from the conning officer to the engine room via the engine order telegraph, as well as by voice over the 1JV sound-powered phone circuit. He or she also monitors the 1JV circuit for communications from DC Central.

The *Status Board Keeper*, also known as the sound-powered phone talker, receives surface contact information from the Combat Information Center over the 1JL circuit and maintains a surface status board displaying all contacts with their updated course, speed and closest point of approach. He or she also receives reports from the lookouts over the circuit to relay to the OOD.

The two *Lookouts*, one forward and one aft, report all visible contacts and objects through the JL circuit. Considered the eyes of the ship, the Lookouts are sometimes called the lifebuoy watch. They maintain an alert watch for man overboards and must have a life ring near their position.

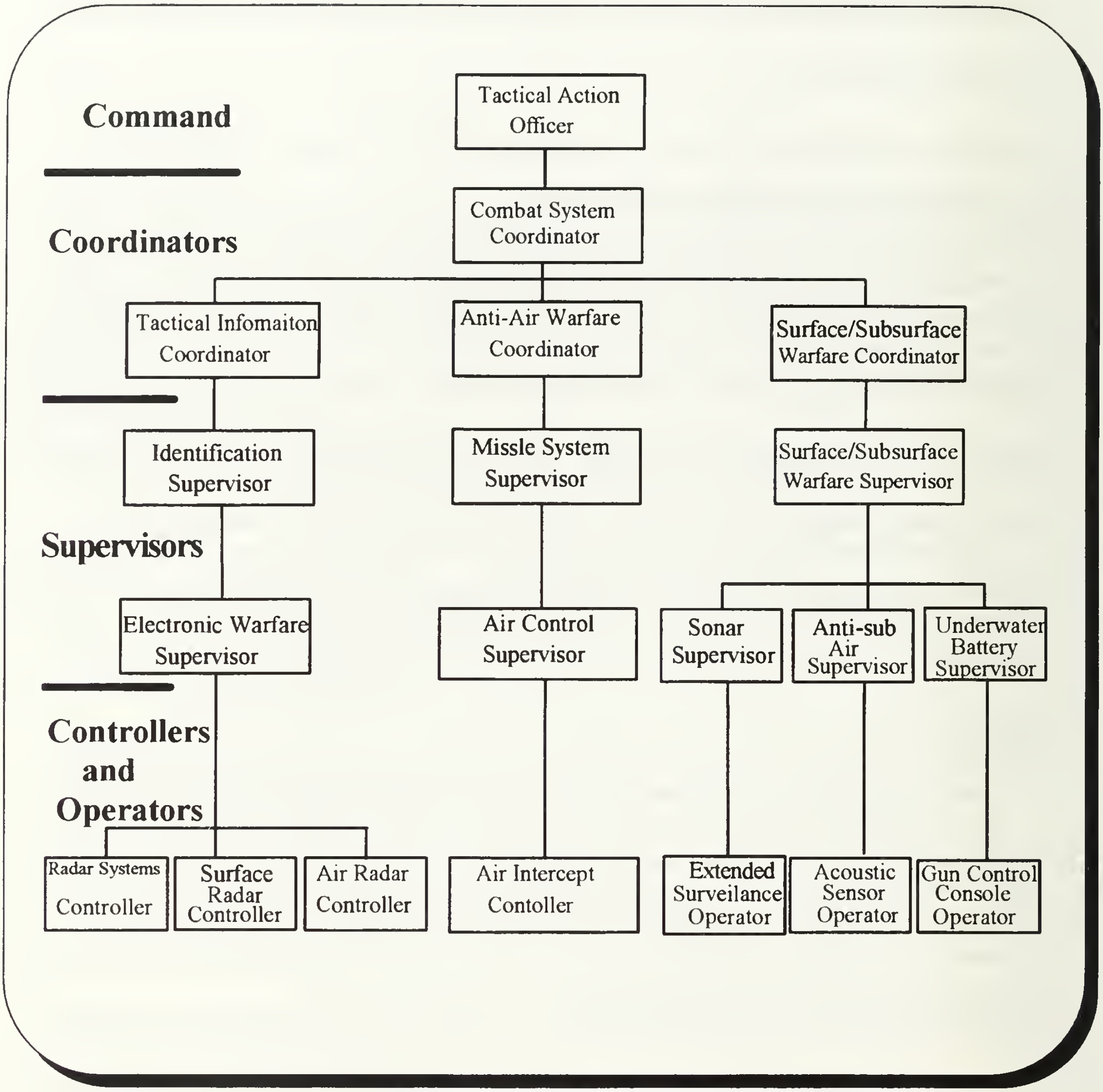
The *Messenger of the Watch* performs miscellaneous duties for the BMOW, including cleaning, polishing the bridge's brass, delivering messages, answering telephones, and waking the watch reliefs from the oncoming watch section. The messenger serves as an extra bridge watch stander allowing flexibility and the rotation of enlisted watch standers.

While not physically located on the bridge, the *After Steering Helmsman* monitors the 1JV phone circuit and as a fully qualified helmsman stands ready to take control of steering locally in the event of loss of steering control from the bridge. The composition of this watch varies from ship to ship. On a frigate, one junior enlisted helmsman fills the watch during peacetime steaming. During General Quarters and other evolutions such as underway replenishment and entering, or exiting restricted waters, a qualified officer, helmsman, electrician, machinist's mate and quartermaster fill the watch. (OPNAVINST 3120.32B, 1986, 4-37)

C. COMBAT SYSTEMS CONTROL

Organized in a similar hierarchical structure, the Combat Information Center (CIC) serves as the control area for the tactical employment of offensive weapons and defensive systems for the ship through the Tactical Action Officer (TAO). OPNAVINST 3120.32B lists the TAO's one primary duty as being "responsible for the safe and effective operation of the combat systems and for any other duties prescribed by the Commanding Officer." (OPNAVINST 3120.32B, 1986 p. 4-16) He or she reports to the Commanding Officer for employment of, and any potential problems in, the ship's offensive or defensive combat capabilities.

While the specific organizational structure varies for each class of surface ship--based on its mission and combat capabilities--the general manning of CIC involves personnel at four levels: Command, Coordination, Supervision and Operation. The organizational structure is depicted on the following page.



CIC Organizational Concept

Figure 2 (NWP 65-28, 1988, p. 2-8)

D. TAKING ADVANTAGE OF NEW TECHNOLOGY: THE NEED FOR A NEW ORGANIZATIONAL STRUCTURE

This organizational structure appears outdated when compared to the evolution that has occurred in private industry. During the 1980s the Navy invested billions on Information Technology but failed to change the basic way in which work is performed, supervised and managed. Private industry also faced this hurdle but overcame it. In the mid-1980s industry's chief executive officers and economists lamented over the billions of dollars invested in information technology with little gain in productivity, quality, or profits. That era appears over. "For the first time the computer is an enabler of productivity improvement rather than a cause of low productivity." (Stewart, 1993, p. 70) This occurred in the private sector after businesses transformed their way of operating. Competition forced a transformation similar to the replacement of steam by electricity.

The 1994 DOD Appropriations Act includes over nine billion dollars for the Navy's Information Technology procurement and maintenance budget. In spite of such a large portion of its annual budget being dedicated to this area, the Navy continues to operate much the same as it did over a hundred years ago. By looking for new organizational structures and new ship designs incorporating technological innovations, and by eliminating obsolete requirements, the surface Navy may find the same savings in personnel and gains in productivity experienced by private industry in the recent past.

E. COMMERCIAL SHIPPING'S SUCCESSFUL TRANSFORMATION

The commercial shipping industry's search for reducing manpower requirements began in the late 1960s. Demographic and cultural changes had created a serious maritime personnel shortage throughout Northwest Europe and Japan. (National Research Council, 1984, p. 29) In the mid-1970s a worldwide recession caused a sharp reduction in shipping, which ended the manpower shortage and forced attention to improving operating efficiencies. These two motivators, with competition, forced shipping companies to continually reduce crew size while improving their ship's productivity through automation and organizational changes.

Today, the crew of a typical U. S. flag vessel totals 20 to 24 personnel compared with over 45 crew members 30 years ago. Some highly automated foreign ships operate routinely with crews of eight or fewer. (National Research Council, 1990, p. vii) Over the past decade, shipyards built ships capable of operating safely with even fewer onboard personnel, but current laws, regulatory policies, and labor-management contracts limit further reductions to below today's levels. (National Research Council, 1990, p. 12)

Commercial shipping companies reduced manpower requirements and improved productivity through a number of changes. Shipbuilders centralized control of all ship functions on the bridge, with comprehensive automation of navigation, propulsion control, cargo operations, safety and emergency systems, as well as external and internal communications. Companies then eliminated the departmental, hierarchical shipboard organizational structure and replaced it with a team-based approach to ship operations.

Fragmented organizations, like that of the Navy's surface fleet, display appalling diseconomies of scale. The diseconomies show up not in direct labor, but in overhead.

> If, for instance, an organization does 100 units of work an hour, and each of its workers can do 10 units an hour, the company would need 11 people: 10 workers and 1 Supervisor. But if demand grew tenfold to 1,000 units of work an hour, the company wouldn't need just 10 times the number of workers plus one manager for each 10 new workers. It would need something like 196 people: 100 workers, 10 Supervisors, 1 manager, 3 assistant managers, 18 people in a human resources organization, 19 people in long-range planning, 22 in audit and control, and 23 in facilitation and expediting.
>
> (Hammer and Champy, 1993, p. 29)

The organizational problems Hammer and Champy found in private industry applies also to the Navy's surface ships. To support the "workers", the enlisted E-1 to E-5 personnel who actually repair, operate or create something, an extensive support system exists aboard surface ships.

These support personnel provide the six or more levels of supervision, process the administrative work, cook the meals and provide the counseling. Much like a small town, each ship operates and maintains a smaller version of a post office, hospital, police force, fire department, bank, general-merchandise store, restaurants, entertainment facilities and schools. Today more of the crew provide support than actually perform effective work.

These characteristics are not new, but until recently the Navy just did not have to worry much about them. Higher overhead costs were passed on to the American taxpayers for payment. Without another source of supply for the service provided by the Navy, the taxpayers had nowhere else to turn. The senior Navy leadership managed the growth of the Navy's budget with little concern for the rising costs of overhead. Now that budget growth has been replaced by budget reductions, the overhead matters a great deal. Navy ships are moving into the twenty-first century with an organizational structure and operating procedures designed during the nineteenth century to work in the twentieth. The Navy needs something entirely different.

III. DETERMINING AND MEETING MANPOWER NEEDS

A. CALCULATION OF MANPOWER REQUIREMENTS

The responsibility for policy control and determination of manpower requirements lies with the Deputy Chief of Naval Operations for Manpower, Personnel and Training with support provided by the Navy Manpower and Analysis Center, NAVMAC. NAVMAC accomplishes its primary mission of developing and documenting manpower requirements for all Navy fleet activities by collecting man-hour data and generating the Ship Manpower Document (SMD). (OPNAVINST 1000.16G, 1990, p. 2-3)

Various methods for determining manpower requirements from these data have been used over the past thirty years. The Manpower Determination Model (MDM), developed in 1967, generated manning estimates early in the ship design process, using historical fleet manning data from ships with onboard components similar to those of the proposed ship. The MDM used a data base of 7000 basic modules for various equipment, systems, subsystems and ship characteristics to compute a total manning package for each condition of readiness. (Arnold, 1980, p. 57-8). According to the technical director of the Navy Manpower Analysis Center, the MDM is no longer used. (Skaggs, 1994)

The current SMD methodology uses the Navy Manpower Requirements System (NMRS). NMRS replaced the Computerized Ship Manning Analysis System in April of 1978 and continues to be used today for preliminary and final SMD generation. Navy planners prepare Required Operational Capability documents and Projected Operational Environment statements (ROC/POE) for each class of Navy ship to serve as a basis for determining Navy military manpower requirements. (OPNAVINST 5310.18A, 1986, p. D-5) As a computer-based model, the NMRS computes manning requirements from workload data measured in man-hours in four major categories: Facilities Maintenance, Planned Maintenance System, Own Unit Support, and Watch stations. (OPNAVINST 3501.10B, 1988, C-9)

Manpower planners collect data for each category using a variety of inputs. For example, watch station man-hour requirements come from the vessel's mission statement interpreted by specially trained manpower analysts who also consider internal ship practices, procedural manuals, naval warfare publications, damage control survivability standards, navy tactical publications and various military instructions. All watch stations are then applied to a watch station standard and the variance and idiosyncrasies of the individual ship taken into consideration. The Navy Manpower Analysis Center then computes billets required using standard allowances and a standard afloat Navy workweek to determine manning requirements for each condition of readiness. (Skaggs, 1994)

The workload requirements for the other elements are allocated remaining man-hours from each billet until fulfilled. For example, on a particular billet there are 56 hours of watch applied as a result of underway operations. That leaves eleven hours of remaining effective time that can be applied to the other three elements from that billet. Allocation to the four elements is applied from each billet until the billet has 67 hours of effective work assigned to it. Another seven hours for service diversion including-- but not limited to--quarters, inspections, CO's non-judicial punishment, and participation on boards and committees along with seven hours for training, complete each billet's workload of 81 hours per week. The latter 14 hours are considered necessary but ineffective time. (OPNAVINST 1000.16G, 1990, p. 5-16)

NAVMAC uses a series of super PCs, which replaced their mainframe system in July of 1993, to input the manpower requirements collected. The computer model divides the man-hour requirements by the standard Navy workweek of 81 hours and computes the total number of hours assigned to each divisional work center by rating. The computer model spreads the individual workload among all determined billets. NAVMAC analysts then take the computer recommendations and manually adjust the billets and apply needed corrections to eliminate and consolidate partial billets. (Skaggs, 1994)

B. SINS OF OMISSION: SOME FAILURES IN THE PRESENT METHOD

There are holes in the present methods for determining manpower needs, and these result in gross inefficiencies and unnecessarily high costs. Some of the things that are not considered by the SMD process include costs, cost constraints, availability of personnel, and bunk space limitations.

> We develop pure pristine requirements that are unconstrained. We assume every billet that we display is fully trained, qualified and motivated to perform the job in which it is assigned.
>
> (Skaggs, 1994)

The SMD process does not include time allowances for crisis management, special project work, personnel management, or the variety of undocumented tasks that shipboard personnel routinely contend with. "The SMDs represent all of the manpower necessary to accomplish the documented shipboard workload in an underway steaming environment without any fiscal, physical, or personnel inventory constraints." (American Management Systems, 1979, p. 1)

C. AUTHORIZING THE MANPOWER

Furthermore, the Navy determines the appropriate manpower level for each surface ship by using estimates of the workload requirements, but *does not question the importance of the work itself*. It then computes the number of personnel to fulfill those requirements given standard hours available in a workweek. Not only is little, or no consideration given to changes in the cost of manpower and of its substitutes but also the planners do not reexamine long-fulfilled and obsolete requirements. Requirements set in tradition and an ever-increasing list of mandated practices cause today's Navy vessels to be manned with hundreds of personnel, each expected on average to fill the Navy standard workweek of 81 hours for military personnel afloat. (OPNAVINST 1000.16G, 1990, p. 5-16)

The Ship Manpower Document generated by the Naval Manpower Analysis Center becomes the basis for a Manpower Authorization (MPA) determined by OPNAV. The MPA specifies the authorized numbers and rating levels allocated to each ship considering Navy personnel constraints. These authorizations are constrained versions of the Ship Manpower Document and only here are the monetary limits of the Navy budget, personnel availability for ship assignment, and some physical limits such as available living and bunk space onboard finally reflected.

One of the most frequent limiting constraints comes from the personnel inventory, which is directly related to the Navy's budget limit. To manage this problem, OPNAV created the Navy Manning Plan (NMP) which specifies the "fair share" of the personnel inventory each ship is entitled to and establishes the general composition of each ship's crew. These NMPs also serve as the baseline for the assignment, recruiting and detailing process. (American Management Systems, 1979 p. 2) This share, as determined by the Enlisted Personnel Management Center, originates from the difference between SMD rating authorizations and the number available in the Navy's personnel inventory for that rating.

The goal of the manpower requirements determination and assignment process is to provide active duty ships with the best practical set of personnel to accomplish their assigned mission. Personnel shortages, space limitations, fiscal and other constraints make it infeasible to provide manpower resources to accomplish all of the required workload, as determined in the SMD process.

Looking at the manpower levels specified for the AE and AFS auxiliary ships by their SMD, authorized, and "fair share" NMP numbers shows a reduction from the number of personnel required to accomplish the documented workload and the crew size with which the ships actually operate. These numbers are depicted in Table 1 below.

Table 1

MANPOWER / PERSONNEL SPECIFICATIONS

SHIP	SMD	AUTHORIZED	NMP
AE28	373	336 (90%)	326 (87.4%)
AFS3	403	404 (100%)	388 (96.3%)
AO145	339	285 (84.1%)	277 (81.7%)

(American Management Systems, 1979 p. 4)

D. WHAT HAPPENS WHEN THE MANPOWER "NEEDS" AREN'T MET?

If the capacity of personnel to accomplish the required workload is less than the demands of the workload documented by NAVMAC, one or more of the following three conditions must exist:

- Shipboard personnel are overworked
- Requirements for outside assistance increase
- Required workload does not get accomplished

The first condition is difficult to determine. Given a standard Navy workweek of 81 hours, personnel may, on average, exceed this limit due to a variety of factors including but not limited to: lack of motivation, insufficient training, inadequate supervision, low skill levels, or a lack of proper tools, materials, documentation and other resources. One indication of overwork may be seen in retention statistics for first term and career personnel, with workload increases and overwork resulting in lower retention statistics. Reenlistment statistics for both groups in the early 1990s have not shown a lower but instead a higher retention level across enlisted personnel ratings over levels experienced in the previous decade. (DOD Military Manpower Statistics, 1991, pp. 32-34)

Workload nonaccomplishment and increases in outside assistance are both more easily determined. Data, reports and inspections have not shown an increase in either of these two areas. "Ships have not indicated an inability to accomplish their mission and workload requirements with the 87 to 92 percent of the personnel the NMRS determined are required to accomplish them." (Sovereign, 1994)

Since the requirement statements documented and collected by NAVMAC serve as the basis for manpower decisions, an incorrect level and number of valid requirements would make these manpower decisions also incorrect. To address these problems and recommend improvements, the Deputy Chief of Naval Operations for Logistics sponsored a program called the Maintenance System Development Program through Naval Sea Systems Command. One product of this program was development of the Shipboard Manpower Analysis System (SMAS) by American Management Systems, Inc.

SMAS consisted of two primary subsystems. The first, called the Manpower Computation Subsystem, computed the manpower necessary to perform all the workload requirements documented by NAVMAC, considering different steaming conditions in port as well as at sea. The system was designed as an enhancement to the NMRS which assumed continuous peacetime steaming and its long at-sea work week.

The second subsystem in SMAS consisted of the Manning Impact Analysis, which identified the workload requirements that could not be accomplished feasibly by a specified number of onboard personnel. This system demonstrated the extent to which the documented shipboard workload requirements were beyond the capabilities of the crews typically aboard Navy ships. (American Management Systems, Inc., 1979, p. 5)

The Shipboard Manpower Analysis System was proposed as a tool to improve the NMRS by identifying the minimum billets required for different conditions of readiness. It demonstrated the ability to defer workload requirements to alternate steaming conditions over the ship's entire operational schedule. "Whatever the potential the system promised, it isn't used today." (Skaggs, 1994)

This work by American Management Systems is just one of many attempts to improve manpower determination for the Navy's surface ships through an evolutionary improvement of the process, *without ever looking at the problem from a revolutionary perspective*. Manpower planners must look for other options, substitutions, or other organizational structures to achieve the same, or at least an acceptable output. With advanced technologies and crews of higher skill levels, the basic operating procedures and organizing principles have become obsolete. Instead of getting these crews to work harder, the solution may be in learning to work differently.

IV. INFORMATION TECHNOLOGY, FISCAL AND PERSONNEL TRENDS IN DOD THAT DEMAND A NEW APPROACH

A. CHANGES IN INFORMATION TECHNOLOGY

Over the last 20 years, information and automation technology changed dramatically. These rapid advances in technical capability have been accompanied by equally rapid reductions in cost.

While many of these technologies could not withstand the rigorous at-sea conditions in which surface ships operate, commercial shipping companies have proven that many technologies can be successfully adopted for shipboard use.

There is a striking similarity between the problems experienced by commercial shipping firms in the 1970s and the current problems in the navy. Competition and the rising cost of manpower forced commercial firms to look for means of reducing shipboard manning levels and lowering operating costs. A decreasing defense budget is forcing the Navy to face the same challenge two decades later.

B. NAVY BUDGET REDUCTIONS

The end of the Cold War, election of a new administration and a growing federal deficit all contributed to the recent decline in the Department of Defense's budget. Table 2 below shows the forthcoming budget by Title in comparison to the previous two years. "The DoD budget request for FY94 was for $250.7 billion, which amounted to a decline of 5% in real terms when adjusted for inflation from the budget passed for FY93 and 35% below the 1985 peak of $350 billion." (George, 1993, p. 195) The Navy budget cuts translated into reductions in active duty personnel, operation and maintenance funds and reductions in the number of surface vessels.

Table 2
DOD BUDGET AUTHORITY BY TITLE
($Billions)

	FY1992	FY1993	FY1994
Military Personnel	81.2	76.3	70.1
O&M	93.8	86.4	70.1
Procurement	63.0	53.6	45.5
RDT&E	36.6	38.2	38.6
Military Construction	5.3	4.5	5.8
Family Housing	3.7	3.9	3.8
Revolving Funds	4.6	-2.2	-2.1
All Other	-6.37	-1.6	-0.7
GRAND TOTAL	281.9	259.1	250.7

(George, 1993, p. 196)

C. NAVY PERSONNEL REDUCTIONS

By 1999, the Navy plans to reduce active duty forces by a total of 170,000 enlisted personnel and 20,000 officers while cutting some 185 ships compared to the Navy of 1989. (Force 2001, 1993, p. 37) Table 3 below shows these cuts in personnel. These reductions force the Navy to consider alternative methods for performing its at-sea mission, with the most likely solutions found by transferring what has occurred in the private sector to the Navy. While the merchant fleet's mission differs from the Navy's, they operate in the same environment with workers from the same population base. Their employees have demonstrated an ability to work effectively with sophisticated equipment and reduced supervision. The Navy should be able to achieve similar results.

Table 3
DEFENSE DEPARTMENT TRENDS

	FY1992	FY1993	FY1994
DoD Budget	$281.9B	$259.1B	$250.7B
Navy Budget	$90.3B	$82.5B	$76.8B
DoD Manpower	1.808M	1.728M	1.620M
Navy Manpower	541,900	526,400	480,800

(George, 1993, pp. 196-8)

D. MILITARY SEALIFT COMMAND'S TRANSFORMATION

Military Sealift Command (MSC) overcame similar obstacles as they transformed their ship operations to more closely match civilian ones. MSC began manning and operating U. S. Navy auxiliary ships in 1972. Since that time, the trend to replacing active-duty ships with civilian-manned ones has increased in the mission areas of sealift, resupply and refueling. The MSC ships cost less to operate and provide equal or better service compared to the active-duty option. (O'Shea, 1994)

A study was commissioned by the Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics in April of 1983 to examine and compare the manning level requirements of active duty auxiliary vessels with a civilian manning option. Information

Systems, a Virginia-based defense contractor, conducted a detailed capability analysis of the manpower requirements, mission capabilities, operational impacts and costs of civilian verses military manning options for auxiliary ships. The contractor found that the civilian manning option was the least costly on an equal capability basis. (Information Spectrum, 1983, p. ii) The results of that study provided the manpower and cost comparison depicted below:

Table 4

MANPOWER COMPARISON

SHIP CLASS	MILITARY MANNING	PROJECTED MSC CREW
AE	392	159
AFS	435	163

(Information Spectrum, 1983, p. iv)

Table 5

MANPOWER COST SUMMARY TO DOD IN FY82 DOLLARS

SHIP CLASS	MILITARY MANNING	PROJECTED MSC CREW
AE	7,502,000	5,724,000
AFS	8,502,000	6,370,000

(Information Spectrum, 1983, p.v)

The manning-level decrease and cost reduction shown above occurs primarily from replacing previously human functions with more efficient and effective technology, and adjusting their operating practices to take advantage of these new capabilities.

The difference between the active duty and MSC manning options would be even greater if the MSC manpower level were based on the actual output or service required of the ship and not on a functional analysis of the Navy's Ship Manpower Document (SMD). To determine the MSC manning level, the Navy requires creation of a "Notional Equal Capability Crew" based on a functional analysis of the Navy's SMD. (Information Spectrum, 1983, p.2-3) By using the SMD, Military Sealift Command is unable to achieve manpower savings through elimination of obsolete requirements taken from the long list of sources used for the Navy's manpower determination. To see the potential, one has only to look at the commercial shipping industry and the direction of private organizations.

V. DIRECTION OF PRIVATE ORGANIZATIONS

A. EARLY PREDICTION

Two professors at the Carnegie Institute of Technology published an article in 1958 titled "Management in the 1980s". In it they predicted that the computer would do to middle management what the Black Death did to 14th-century Europeans. (Leavitt and Whisler, 1958, p. 44) Evidence supporting the validity of their prediction can be found in a study conducted by the American Management Association. The study found that reductions in middle management accounted for 16% of corporate reductions with demographic forecasts pointing to a continuing trend in layoffs. (Capell, 1992, pp. 44-45)

B. TRADITIONAL VERSES MODERN MANAGEMENT

The traditional line management organization has had a boss who gives orders; an enforcer in the form of a foreman, who sees that those orders are carried out; and the workers, who are supposed to do what they are told without asking very much about why. Over the past 25 years or so--to some extent looking at other cultures, especially Japan, and modern psychological experiments--many successful firms have moved away from that traditional view. While the range of variation is substantial, the keys are probably found in the management-by-objectives style, commonly called Total Quality Leadership or TQL. These approaches, while substantively trivial, try to make people at all levels part of the team and provide them with goals that are clearly related to the larger goals of the organization. Other key elements of TQL include having an agreement about what these goals are, and providing a lot of feedback.

During the past decade, successful organizations realized that technological change was moving faster than their organizations were adapting and as a consequence the benefits afforded by new technologies were not being fully exploited. They sought strategies that reduced the threatening nature of new technologies and enabled their executives and workers to employ them more effectively. In working out these new strategies, management sought better insight into how their organization functioned and how it communicated and achieved objectives.

Both the formal and informal organizational structures affect what people do and how they do it, their communication and relationships with peers and supervisors. "Formal structures imply rules, while informal structures are real life interpretations of those rules." (Smith, 1990, p.14) Formal structure--planned and specified through official channels--establishes responsibility, authority, and how communication moves through the organization, a static system. The informal structure develops when people work together and interact over time. The organizational structure of many successful companies resulted from grouping functions necessary to achieve the organization's objectives.

Some desirable attributes of organizational structure:

- Be catalytic in getting the job done in the most productive manner.
- Never be an end in itself, but only a means to achieve the best possible use of available resources.
- Identify responsibility, decision-making, authority and performance accountability in a precise manner.
- Be simple, flexible and adapt to change. (Smith, 1990, p. 14)

This seems to be the direction that business organizations are taking. When all the problems of measurement are stripped away, we see that trial and error play an important part in successful management. Successful businesses continuously monitor achievement. By timely and appropriate revision of goals and strategies, they keep their organizations competitive.

C. CHANGES FORCING TRANSFORMATION

Many changes forced businesses to adapt in the past decade: new taxes, state and federal regulations, increased environmental concerns and the move away from traditional family units, to name just a few. Nearly all firms have felt the impact of rapidly changing technology. These rapid technological changes required continuous monitoring of major organizational assets: financial capital, time, resources, inventory and the like. Widening technological gaps occurred as technological advances occurred faster than they were assimilated. A responsive, enlightened management and a well-trained work force helps keep this gap small. (Smith, 1990, p. 29)

One innovation made possible by new technologies was streamlined inventories and supplies, assisting companies in becoming more cost effective. Just-In-Time delivery (JIT) minimizes cost and effort through production scheduling and inventory control. The Toyota Motor Company developed the Just-In-Time concept in Japan. Productivity savings increased profits by balancing the effort and cost of maintaining an adequate inventory against the expenses and logistics associated with on-time delivery. Wastes and costs of production drop due to a reduction in excess inventory. Toyota found that through their new system, needed production materials remained readily available and quality actually increased due to retaining defective and obsolete inventory. Black and Decker Manufacturing and Motorola recently joined the long list of American companies implementing the Just-In-Time system in the United States. (Smith, 1990, p. 161)

JIT is just one innovation made possible with the evolution in information technology. New abilities in communication, information processing, product designing and inventory management, as well as a host of other areas, dominate the work environment. The impact of technology remains high as well as the cost of resisting the necessary changes needed to use it. An organization's size, age, culture and leadership affect the degree to which new technologies get assimilated. In the mid 1980s older, large organizations resisted changing their organizational structure and methods of doing business while new, small businesses embraced more efficient means of achieving their goals. While Sears lost market share, Wal-Mart and The Gap thrived. General Motors has trouble making world-class cars in America, but Honda doesn't. Bethlehem Steel has shrunk to a tenth of its former size while Nucor and other minimills are performing well. (Hammer and Champy, 1993, p. 24)

D. EXAMPLES FROM PRIVATE INDUSTRY

Business organizations transformed due to information--a dominant resource--becoming expandable, compressible, substitutable, highly transportable, diffusible and sharable. (Smith, 1990, p. 162). A few examples of the changes in American companies in the past few years:

- Autos. Cost cutting, design changes and quality improvements. Automakers are less bureaucratic, more flexible, more customer minded, driven by competition outside the unchanged U. S. firms.

- Electronics. A capital spending boom is raising productivity. One firm checks production by computer . . . doing the job of 50 engineers.

- Insurance. Records have now been consolidated and computerized. Agents get instant access to all data and customers get better service. (*Kiplinger*, Jan. 21, 1994, pp. 1-3)

- Distribution. A distributor in Pa. saves labor and money through electronic ordering, invoicing, paying and depositing. . . . catching on fast, electronic networks of sellers and customers.

- Trucking. A trucking company in Green Bay links sensors in the trucks to satellites to keep track of location, speed, rpm's and idling time for its fleet. If drivers meet company goals, they earn yearly bonuses up to $6000.

- Communications. New communication systems save time, travel and expense. Teleconferencing and videoconferencing are replacing face-to-face meetings in many situations with documents passing back and forth by fax machines. New fax-retrieval systems allow callers to go through a touch-tone menu and get reports they need . . . sales material, price lists, etc. (*Kiplinger* Oct. 29, 1993, pp. 1-3)

In these transformed organizations *more* information is not better but *access* to it is. "Exchanging, buying, analyzing, protecting, storing, retrieving and disseminating information approaches a nationwide preoccupation." (Smith, 1990, p. 162)

With a hierarchical organizational structure, the more important the information the further down in the organization a person must go to get it. The workers at the process level possess the knowledge of the quality of incoming supplies and outgoing products and services, and usually have the best ideas for improvement. Successful businesses in the 1980s moved to a flatter, more participative management structure based on the premise that people possess the necessary leadership ability, mental capacity and desire to work together on common goals and objectives. Employees throughout the organization possess the right mix of knowledge, information, power and incentives to have a positive impact on organizational performance. They delegate decision making to the lowest possible level. At this level, the participants know the task better than any other person and are the best qualified to improve the process by making the decision. This type of management results in employees supporting what they help create and developing a sense of accomplishment and ownership.

The President of Trus Joist Corporation found that his company achieved the greatest productivity gains without investing a single dollar in new equipment or technology but by letting employees participate in the business with their ideas and enthusiasm. "In our company the greatest productivity improvements have come when we enlisted the hearts and minds of our associates on the factory floor." (Minnick, 1986, p. 131)

Businesses created flatter organizations based on a team structure to improve productivity, reduce overhead and minimize conflict. Using these small work groups placed a much higher degree of decision-making responsibility and control in the hands of the people most affected by the decisions. Cost savings occur through reduced monitoring, more efficient use of worker's time and a reduction in the number of inferior items produced. "Approximately 200 plants in the U. S. have begun using the self-managing team concept." (Sims and Dean, 1985, p. 25). Some of the advantages and drawbacks to using this new team concept were identified by Sims and Dean.

<u>Advantages are</u>:

- Members develop a variety of skills and are encouraged to learn more about numerous jobs performed by other team members.
- Teams are highly adaptable and flexible.
- Responses to changing conditions and new startups are uniform because of training.
- Adapting to new processes and equipment is relatively trouble-free and is exemplified by a "can do" attitude.

<u>Disadvantages are</u>:

- Startup costs can be significant.
- Middle managers in particular feel highly threatened. Their unfounded fear is that teams will reduce their power and influence.

(Sims and Dean, 1985, p. 27)

Business practices of leading companies in the 1980s marked a significant departure from their traditional modes of operations, with increasing roles accorded to the capabilities and opportunities offered by information technology. The most successful transformations occurred in organizations that recognized and understood benefits from IT come only with fundamental changes in strategic choices, internal processes, worker relationships and responsibilities. For organizations in the competitive world of modern business, the environment of work suddenly changed. Trade periodicals and journals tell of the transformations hundreds of companies made in order to remain competitive in this new world of technology.

General Electric plant workers set production schedules 50% higher than management had previously set. Shenandoah Life Insurance Company's employee-to-supervisor ratio changed from 7-to-1 to almost 37-to-1, while service improved and complaints due to errors declined. At Digital Equipment's plant in Enfield, Connecticut, workers eliminated supervisory positions. Ford's plant in Hermosillo, Mexico blends all assembly workers into one job classification, with each person responsible for his or her own quality control and equipment maintenance. (Sherwood, 1988, p. 5-6)

E. CHANGING WORK PROCESSES WITH INFORMATION TECHNOLOGY

These organizations succeeded in accommodating the design of their IT system to match employee skill level, and in transforming the organizational structure to achieve the most productivity for any given input. Decentralized decision making, continuous learning, challenging jobs and more responsibilities with attractive and challenging career paths provided new motivation to employees. The results are remarkable.

Private companies now find themselves able to provide better products and services with vastly fewer people. Volkswagen needs only two-thirds of its present work force to manufacture automobiles. With its sales volume rising, Proctor & Gamble dismissed 12% of its employees. CIGNA Reinsurance cut its work force by 25% since 1990. (Stewart, 1993, p. 66) With the aid of technology, leading organizations transformed from the command-and-control hierarchy they adopted from the military over 100 years ago. These companies became information-based organizations with specialists directing and monitoring their own performance through feedback from other workers, customers, suppliers and sometimes even corporate headquarters. "Employment is moving fast from manual and clerical workers to knowledge workers who resist the command-and-control model." (Drucker, 1988, p. 3) With new technology, the need for layers of management to advise, coordinate and counsel decreases dramatically; and productivity improves. The head of General Electric's Lighting division, John Opie, explained the impact on his organization with this statement: "There are just two people between me and a salesman. Information Technology replaced the rest." (Stewart, 1993, p. 72) Thomas Stewart, in "Welcome to the Revolution," explained: "The fall of hierarchy frees the man in the gray flannel suit from his office, his boss, his boss's boss, his boss's boss's boss - not to mention the suit." (Stewart, 1993, p. 70)

As the nation's largest utility with local telephone systems from Maine to Hawaii, GTE Corporation is among reengineering's most prominent converts. Workers who once fielded complaints from angry customers passing them on to repair technicians can now attempt to resolve problems themselves with the customer still on the line. Performing remote tests on customer telephone lines corrects problems much faster, reduces the need to send expensive repair technicians on house calls, and makes the job more interesting. (Levinson, 1994, p. 49)

As private companies implemented new information systems, they found that achieving the full benefits of information technology requires transforming the structure of organizations from the traditional hierarchical form to a flatter, more participative relationship. Researchers conducted various studies on the implementation of new technology and organizational change in the past decade. The Massachusetts Institute of

Technology sponsored one such study on the automobile industry through its International Motor Vehicle Program. Researchers gathered data from one Honda plant in Ohio, a Nissan plant in Tennessee, two General Motors plants in Massachusetts and Michigan, and a joint venture with a General Motors and Toyota plant in California called NUMMI. The five automobile assembly plants studied by the researchers varied in the amount of technological and organizational change implemented as they responded to increasing competition.

The organizational transformations took the form of changes designed to encourage employee commitment and participation and improve competence. They achieved this through flexible assignments, multiple skill training, self supervision, worker quality improvement, problem-solving teams, and other participative mechanisms. With a variance in the degree of technological innovations and organizational reform, the researchers studied changes in the productivity and quality improvement with startling conclusions.

> Advanced technology by itself fails to achieve performance gains. Only when innovation in work organization accompanies technological innovation do we see significant performance advantages.
>
> (Krafic and Womack, 1986, p. 7)

These researchers found the same conclusion when studying advanced technology and work organizations as researchers found studying the introduction of electricity and work organizations in 1919.

Private industry moved fast from manual and clerical workers to knowledge workers. Information-based organizational structures replaced the command-and-control models that business had adopted from the military. (Drucker, 1988, p. 3) Information technology demanded the shift through competition.

The surface Navy can learn by taking a business perspective in integrating information technology in the evolution to smaller, more capable, less manpower-intensive surface ships. In the 1980s private companies realized their poor performance when compared to the competition and changed their operations to take advantage of new technologies in order to remain profitable. The Navy may find it can emulate those organizations which reengineered their work processes and achieve similar spectacular results.

VI. IMPLICATIONS FOR NAVAL SURFACE SHIPS

After over two hundred years of evolutionary changes in surface ships operation and organization, the time has come to reevaluate the system, retire the old principles and create a new, revolutionary set. The United States needs surface units organized and designed specifically to operate in today's world, using today's technologies-- not historic structures carried over from earlier, glamorous but no longer relevant times. The Commander of Military Sealift Command gave his perspective on the problem in a speech in March of 1994.

> MSC is one of the only areas of DoD where allocations are actually increasing and why is that? We operate closer to the real world where there's just three commodities: time, money and people. We're expected to operate lean, right and awfully damn quick. Samuel Johnson said it best: "The prospect of hanging tends to sharpen the mind." The key's not working harder. We're thinking harder and finding the payback is about five to one.
>
> (VADM Kalleres, 1994)

Over time the Navy has created an enormous bureaucracy ashore as well as on its ships at sea. To attain predictable, uniform actions from their subordinates, superiors created formal operating procedures with an organizational structure and feedback mechanisms needed to carry them out. The Navy created an instruction for virtually every contingency, with lines of authority, responsibility and reporting clearly drawn.

With fleet-wide application of these thousands of procedural requirements, as well as those generated internally on each ship, the overhead work and increasing administrative burden now place those who work at sea at a crossroads. Today's decreasing budget and increasing mission objectives force radical change--searching for new ways of getting work accomplished with minimal interference, emphasizing results and not procedures. (Osborne, 1994, p.15) As important as they are, it is clear that procedure-based activities are the wave of the past. The wave of the future is applying information technology to goal-based activities. (Sprague and McNurlin, 1993, p. 18) This would mean telling the surface ships what goals they are to accomplish and allowing the workers at the process level to determine how best to meet those goals.

The Chief of Naval Operations understands this as one of the surface Navy's current problems and in July of 1994 explained it as follows:

> The Navy's got all these groups working for one purpose: their own. Somewhere in the Navy is an office with a plate on the door called Asbestos Removal and they're putting out instructions and requirements to the fleet. Somewhere else, working just as hard, is another group putting out instructions and guidelines on Physical Readiness. The list goes on and on. Pick a topic and there's probably some instruction on it. Now these groups don't talk to each other and why should they, but when their instructions get down to the process level, these things come together where today we've got sailors doing a lot more overhead instead of the work they were trained to do.
>
> (Admiral Jeremy M. Borda, 1994)

A. REENGINEERING THE WORK OF SURFACE SHIPS

In their book, *Reengineering the Corporation*, Michael Hammer and James Champy tout "reengineering" as the tool for radical change, with the enabling role of information technology at its heart. They define reengineering as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed."

(Hammer and Champy, 1993, p. 32) In their concept, old titles and organizational arrangements by department, division and work center cease to matter. "They are artifacts of another age." What matters is how work needs to be organized today, given the demands of today's problems, talents of today's workers and the power of today's technologies. (Hammer and Champy, 1993, p. 2)

As surface ships reengineer their work, the crew's job evolves from narrow, task-oriented assignments to multidimensional responsibilities. Sailors who once followed orders now make choices and decisions on their own instead. Officers and chiefs stop being supervisors and become facilitators. Sailors then focus more on the needs of the job and less on the needs of their superiors.

Information technology plays the crucial role of enabler in the process. What was once *impossible* is today *practical* given the evolution in computer technology. Navy surface ship planners realized the benefits of new technologies and installed high technology weapon systems, engineering machinery controls and other equipment throughout surface vessels. These ships fail to achieve the full benefits of these new systems by not changing the nature of how the crew operates with them.

B. NEW TECHNOLOGY, OLD PROCEDURES

> The Arleigh Burke (DDG 51) class ship uses more than 1200 standard electronic modules in its engineering machinery control system. Six microcomputers monitor and control onboard equipment, with each device polled twice per second through a sophisticated multiplexing system. The network allows passage of millions of bits of data each second.
>
> (Preisel, 1988, p. 121-2)

Despite these advances, sailors continue to take manual readings and store the data on paper log books with engineering chiefs and officers reviewing the unprocessed data. Humans can never achieve the speed, reliability and efficiency of a computer-based application to perform the task. Computers could look for trends. Have oil temperature, or vibrations increased? Has the output of a pump decreased compared to its designed head/flow curve? What is the acceptable degradation before repairs are required and the projected time to individual component and total system failure. "Processing this data should be left to a computer and interpretation of the information should be left to the engineer." (Preisel, 1988, p. 124)

Damage control encompasses another shipboard mission area with potential manpower savings and productivity increases. Aboard even the newest surface ships, the damage-control process requires the crew to:

1. Fill out paper message forms reporting emergencies; The forms are then sent by runner to Damage Control Central.
2. Identify compartments adjacent to the site of emergency to be sealed.
3. Notify the Officer of the Deck and Commanding Officer, as well as other officers and senior enlisted personnel.

(OPNAVINST 3120.32B, 1986)

Even with a well-trained and battle-ready crew, the communication process becomes dangerously complex, exponentially so in a multiple crisis scenario.

In 1993 the CAE-Link Corporation developed a Shipboard Monitoring and Control System (SMCS) for the Naval Sea Systems Command. One element, the Battle Damage Control section, significantly reduces the time to report and analyze shipboard damage with dramatic increases in accuracy when compared to the manual method. (Walsh, 1993, p. 37) The current version of SMCS continues to rely on manual input of damage control symbology by operators using a computer mouse. The technology exists to link the system to remote sensing devices installed throughout the ship, monitoring temperature, pressure, humidity and particulate matter to generate real-time condition reports, eliminating the need for human operators.

C. NAVIGATING IN A NEW WAY

The introduction of new technological equipment changed the way commercial shipping interests now operate ship control and navigation, and may provide the surface Navy with similar productivity gains and cost savings for bridge operations. A symposium of maritime interests held a convention in London during the fall of 1992. Three hundred delegates from twenty countries considered the following proposition: "This house believes that safe and efficient transport no longer requires paper charts and maps." (Walters, 1993, p. 203) The fact that a majority of the delegates rejected the proposal is not surprising, considering that they represented the world's navies and not commercial shipping industries. Manpower costs directly affect the profitability of commercial organizations, explaining their motivation to begin replacing personnel with more effective and efficient electronic equipment over a decade ago.

Perhaps paper charts and manual methods should not be discarded completely. Just as the Navy keeps the sextant and magnetic compass to back up satellite navigation and the gyrocompass, the Navy should adopt the electronic counterpart of the paper chart for navigation. Sperry Marine's Voyage Management System satisfies all international guidelines for "one man bridge" operation. (Sperry, 1990, p. 2) The NAVSIT module provides a real-time display of the ship's current position on a uniform, accurate, up-to-date electronic chart. As the ship transits, the next chart is automatically displayed with the ship's position plotted. Unlike the paper chart, Sperry's product offers autopilot, collision avoidance, route planning, replay capabilities, and route storage for future transits, as well as a host of other capabilities. Commercial shipping companies routinely operate their vessels equipped with these systems and one watch stander on the bridge. (Sperry, 1990, pp. 2-5)

D. NEW MISSIONS FOR TODAY'S NAVY

With a revolutionary perspective, commercial shipping companies changed the nature of their work in response to new technologies. Following the dramatic changes regarding the former Soviet threat, one thing remains clear: The size of the Navy will become smaller, and the mission of the Navy broader. "Today there're 43 countries that may need our help and a lot of that need is nontraditional." (VADM Kalleres, 1994) Reviewing the following operations the Navy has recently engaged in provides some sense of the expanding roles being faced today.

Table 6
RECENT MAJOR OPERATIONS

Drug Operations	Caribbean	1989 - Present
Maritime Intercept	Persian Gulf	1990 - Present
Provide Comfort	Turkey / Iraq	1991 - Present
Haitian Refugees	Guantanamo	1991 - Present
Provide Relief	Kenya	1992 - Present
Maritime Monitor	Yugoslavia	1992 - Present
Hurricane Andrew	Florida	1992
Hurricane Iniki	Hawaii	1992
Typhoon Omar	Guam	1992
Southern Watch	Iraq	1992 - Present
Restore Hope	Somalia	1992 - Present

(Force 2001, 1993, pp. 12-17)

Ships no longer spend their time at sea conducting large-scale antisubmarine warfare exercises and Naval gunfire support training. "Today's exercises are indistinguishable from the real thing and the boundaries between training and peacetime operations are often ambiguous." (Force 2001, 1993, p.8) If the Navy approaches these new, broader missions classically, using current methods and an obsolete perspective, it may not succeed. VADM Kalleres described the preparation for the Restore Hope operation this way:

> Getting ready for Somalia wasn't dull. That's for sure. At first we approached that mission classically, just like it was another Desert Storm. People pulled out their manuals and started loading artillery. They weren't thinking ahead. Too many paradigms in the way. Somalia was a different problem.
>
> (VADM Kalleres, 1994)

These problems may be overcome by taking a revolutionary look at how our ships are designed and operated. Forgetting what the Navy has today, what would a new ship look like? How would it perform its mission? What kind of support would it need, and what size crew would sail on it?

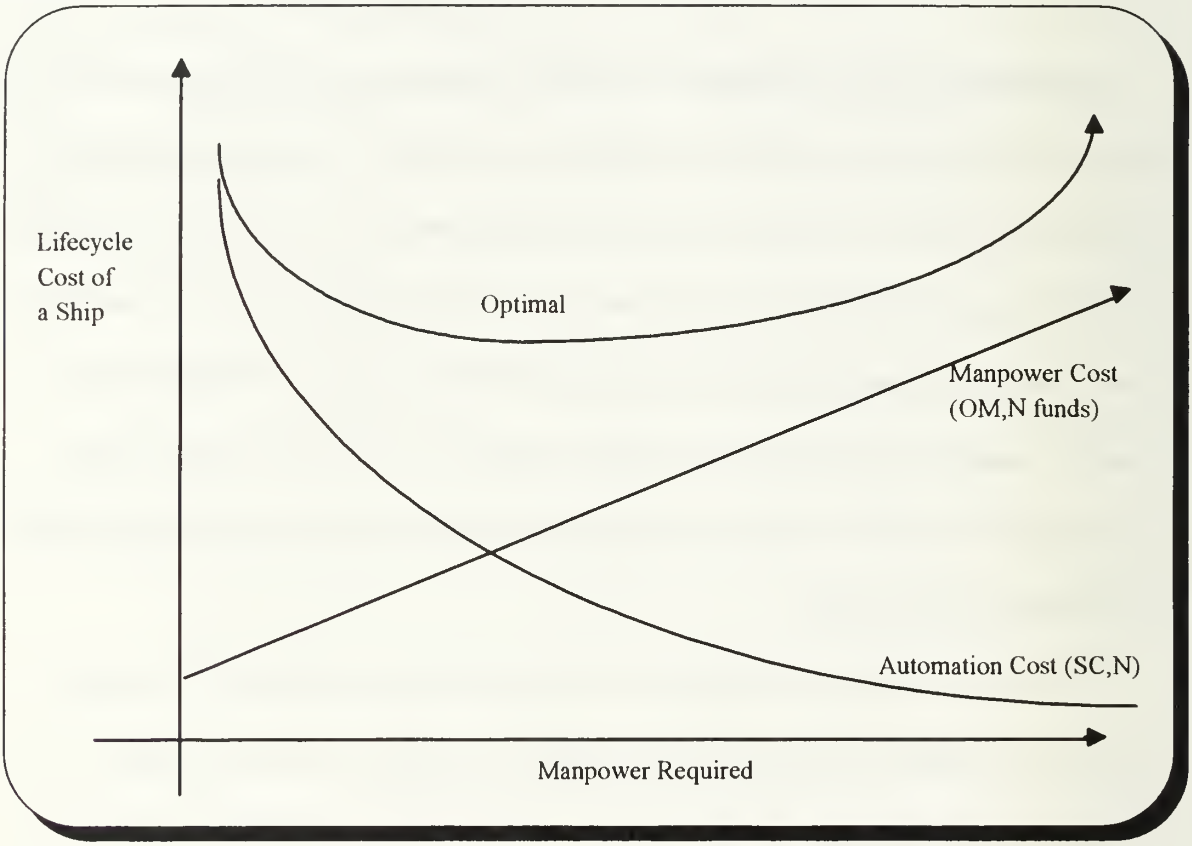
VII. A NEW SHIP DESIGN CONCEPT BASED ON CURRENTLY AVAILABLE TECHNOLOGY

> We must structure a fundamentally different naval force to respond to strategic demands . . . . Our goal is to focus our procurement strategy on systems that best support the unique capabilities of the Navy and Marine Corps.
>
> (. . . FROM THE SEA , 1992, pp. 1-2)

Responding to the new direction set forth by the Secretary of the Navy requires a new approach to the way the surface Navy fulfills its at-sea mission. The Navy must build ships with automation in mind from the initial design phase. It must eliminate the need to fulfill the long list of shipbuilding requirements and have a simpler goal: to provide the Navy with an affordable ship that is rigorous and combat-capable, while being easy to operate, maintain and engage in battle with a smaller crew. One way to attain these simpler goals combines automation and manpower issues early in the ship design process and addresses the tradeoffs.

This means building new ships around a high-performance, distributed computing system with multiple access and backup capabilities to achieve optimum, efficient manpower and automation levels.

Currently available technology allows for the reduction in manpower requirements through automation, resulting in even more reliable, efficient and cost-effective systems than we currently have at sea today. After an over 200-year traditional way of operating, many paradigms obscure this new ship design. Starting from a blank conceptual base with no requirements other than those stated above, many ideas come to mind. Clearly it makes sense to design the ship first and then tailor a new organizational structure to most effectively fight, operate and maintain the ship in its at-sea mission. The installation of automated systems would increase the up-front construction costs but reduce the ship's lifecycle costs through manpower savings. Figure 3 below depicts the projected lifecycle cost curve.



Projected Lifecycle Cost Curve
Figure 3

The Chief of Naval Operations stated his idea on the issue in July of 1994 in a speech in Monterey, California at the Naval Postgraduate School.

> Shortly after I took over in April I began asking some questions. I've got something called the CNO Executive Panel and asked them to look at a new concept: What if we design our next ship revolutionary instead of evolutionary? Forgetting what they look like and how they operate today, what would this new ship look like? It's an interesting question. (Admiral Jeremy M. Boorda, 1994)

A. SHIP CONTROL

Considering currently available technology and the potential manpower savings, many ideas come to mind for designing an evolutionary surface ship. Imagine a new ship where the Navy has combined the Bridge and Combat Information Center into one internal, hardened Command Center with external and internal viewing capabilities. Further imagine large visual display screens allowing for 360-degree external views from the ship and selected internal displays of critical combat and operational spaces. Linking these displays to combat sensor equipment allows for selection of air search, surface search, sonar, infrared, night vision, or visual modes from which the two watch standers monitor the tactical picture. An automated navigational system based on GPS satellites allows for ship fixes within two to four meters of actual position. (Walters, 1993, p. 203) Routing that constantly updated information to fire control systems, ship control (autopilot) and even engineering equipment provides more effective use of the information.

Seasoned mariners feel a need to be part of the external environment for safety reasons. Contrary to that perception, a study by the U. S. Coast Guard found that 88% of marine casualties occur in clear weather, with the other ship plainly in sight, and with communications well established. "Despite their experience and expertise, mariners have never seen, or felt all of the infinite and constantly changing conditions, and situations that occur at sea." (Gates, 1989, p. 2-3)

Currently available commercial marine products monitor the ship's speed and position, and the relative and true wind conditions. It is technologically possible to share this information with the ship's self-defense systems. These now integrated systems could detect an inbound missile, automatically turn the ship in the direction of safe water, launch heat or aluminum chaff decoys, and recommend countermeasures.

B. ENGINEERING CONTROL

With a similar design Main Control could monitor main engineering and auxiliary spaces and serve as a back-up hot site from which to control and fight the ship if the primary command center were destroyed. With a modern ship equipped with sensors and automatic control devices, with multiple readings fed to multiple systems, engineering watch stations reduce from 15 to three people. With control devices and data from the navigational system, garbage, oil and CHT (sewage) equipment could be set to discharge automatically but only when outside international limits from shore with manual overrides in case of emergency.

Main Control could also monitor each space for temperature, humidity, and airborne particulate matter, and route that information to a database for log-keeping, an air conditioning system for environmental control, and a damage-control system for automatic fire suppression and battle-damage displays. Except for Main Control, all propulsion and auxiliary system spaces operate unmanned. By automated monitoring and control mechanisms, adjustments to the propulsion system based off seawater injection temperature allows for more efficient operation of the engineering plant. Tank level indicators and pumps adjust fuel oil, lubrication oil and freshwater tanks to achieve automatic feed and enhance ship stability and fuel savings.

C. DAMAGE CONTROL

Equipping the ship externally with chemical, biological and radiological sensors allows automatic closing of air intakes and activation of water wash-down systems. Fire and flooding sensors installed in each space feed data to a ship schematic display enabling damage-control personnel to take corrective action. Armored plating serves to shield critical ship control and engineering spaces with backup life support systems in the event of attack. Electronic wall displays receive the status of each shipboard space with the X-ray, Yoke and Zebra status constantly displayed.

Material Conditions of Readiness

X-ray: set during working hours in port by divisional damage-control petty officers; provides the least protection, the least degree of watertight integrity; closed even when the ship is not in danger of attack; must be logged open in the closure log; set only in secure harbors and naval facilities. All fittings marked XRAY (X) are closed at all times except when actually in use.

Yoke: Normal peacetime in port and underway cruising condition. All fittings marked "X" and "Y" are closed at all times except when actually in use.

Zebra: Set during peacetime emergency evolutions and wartime battle stations. All fittings marked "X", "Y" and "Z" are closed. They are opened only after receipt of permission from Damage Control Central.

(Bissell, Oertel et al, 1976, pp. 26-31)

A battle damage-control system built on the CAE-Link Corporation's concept of protection automation monitors shipboard spaces for hazardous conditions. (Walsh, 1993, p. 37) With this concept of unmanned propulsion and auxiliary equipment spaces, the probability of fires falls significantly if the spaces operated are sealed and over-pressured with inert nitrogen gas. In the event of fire detection from increases in heat or in airborne particulate matter, the system activates a warning strobe and alarm for personnel evacuation along floor escape lighting, similar to those used onboard commercial aircraft. After a 30-second delay, the system seals the space and floods it with Halon gas to suppress the fire. Similarly, flooding sensors and alarms monitor bilge water levels activating float-controlled bilge pumps for deflooding.

Because of electronic monitoring and automatic activation of damage-control equipment, the system's memory banks serve as a "black box," similar to the commercial airline industry's flight data recorder. The capability of recovering final audio crew tapings and critical equipment readings after a shipboard incident allows investigators to learn more from maritime disasters. Additionally, the knowledge of the events leading to an onboard disaster assists Navy planners in the prevention of future incidents.

D. MAINTENANCE

By sensing, monitoring and recording operational parameters of equipment, their true condition could be determined, trends detected and optimum settings made for more efficient operating and servicing of the equipment. The Navy could move from the time-based Planned Maintenance System (PMS) to a condition-based one, servicing equipment only when needed. A database of equipment readings logged by a computer system would be more reliable than today's paper-based logs, easier analyzed and more useful to designers, contractors and maintenance personnel working on these systems.

Technical manuals and schematics on computer disk instead of paper optimizes space savings and weight reductions while providing a host of useful capabilities not achieved with paper-based technical manuals. New disk-based information retrieval systems allow for easier, faster searches and more useful displays of needed information. Maintenance personnel could retrieve needed data at the system or component level displaying the impact of corrective actions on linked systems throughout the ship. With access to audiovisual communications, shore-based technicians could work on problems beyond the scope and skill level of the ship's crew, and could assist with repairs through their view of the actual equipment--eliminating much of the need for the costly travel to ships which are in need of technical assistance.

E. SUPPLY

With much of today's inventory control using the bar-coded Navy Stock Number (NSN), current procedures could be taken further to virtually eliminate the need for an afloat supply department on Navy ships. When a part or item is pulled from the onboard supply by the actual personnel needing the item, the system automatically updates the onboard database. Daily transmission of the changes to the onboard supply allows shore-based systems to prepare needed materials for shipment when the onboard supply falls below preset minimums. With more frequent consumption information, shore-based supply depots and commercial suppliers now possess the capability to institute the growing commercial practice of Just-In-Time delivery. With these shore-support organizations monitoring the changes in the consumption rate of supplies for individual ships and the entire fleet, they can work with DoD contractors to adjust manufacturing before shortages appear and decrease production for materials at surplus levels.

F. HABITABILITY

The damage-control system monitoring space conditions, when linked to the hospitality services of air conditioning and heating, allows space temperatures and lighting kept at optimum settings based on manned or unmanned status. The limited crew size allows for individual berthing compartments with space for entertainment, training and education. Without a large crew, the dining facilities may now operate similar to commercial shipping vessels. Menus can be created based on choice and prepared by rotating onboard workers, increasing the variety of meals and eliminating the need for shipboard cooks.

G. PERSONNEL, DISBURSING, POSTAL, ADMINISTRATION OFFICES

Current communication capabilities allows transfer of most of these functions to shore stations with access and update capabilities from sea. The now smaller crew demands less of these functions. A highly trained and educated crew possesses the capability to maintain their own personnel records when at sea, cash their own checks if needed, conduct the ships daily routine and send and receive their own mail without enlisted specialists.

H. SECURITY

The intelligence commands in Washington currently use a system easily adaptable to shipboard applications. Their security systems control access to various spaces to authorized personnel, based on an access list matched to the security clearance and need for entry. It automatically logs the time of entrance and exit as well as keeping an updated database of all personnel's current location within the facility. (Adams, 1993, p. 33)

As done in private companies, personal code numbers and smart cards eliminate the need for a quarter-deck watch and maintains a more accurate, detailed log of entries and exits for monitoring. The personal codes and smart cards also control access to critical internal spaces and computer equipment.

I. COMMUNICATION

For external communication requirements, a radio message traffic system based on E-mail delivers communications to the ship with automatic routing to the intended recipient. Bridge-to-Bridge radio capability would be enhanced by stored tape recordings of standard warnings of danger for live at-sea gunfire exercises and threatening maneuvers in the dominant languages in the operating area. For internal communications, personal communicators eliminate the need for a public address system and can be enhanced to monitor physical location, radiation doses, biological signs and other personal data readings.

J. TRAINING

New Personal Qualification Standards designed around a computer system for teaching and testing enhances crew learning at a self-pace. With one level completed satisfactorily, the crew member moves to the next training level with the system tracking progress for advancement and new watch station qualifications.

By adding simulator capability in the Command Center and Engineering Control, the crew could train using the actual equipment. When in port, the more junior and inexperienced officers and crew can run maneuvering or casualty control drills--and see the results of their action--without damaging the ship.

Educational services via satellite or disk from Navy classroom lectures or civilian training facilities allow the crew to increase their education and training without the cost of travel and lost work time away from the ship.

VIII. CONCLUSION

Faced with better adapted competitors, private companies realized their poor performance and need to integrate information technology into their business process through radical change. Instead of operating their organization by departments and functions, they examined their operations from a new perspective: by process. They focused on the value-added outcome of each process--why a task was performed, not how it was done--and how it related to other processes in the organization. Private companies found that continually questioning assumptions and requirements of what needs to be accomplished and by which method yielded impressive insights.

The benefits of using new technologies at first evaded the most progressive companies. They found new systems could speed up existing work steps without eliminating the causes behind poor performance. If the outcome of current procedures yielded an unnecessary result, the new systems would generate the same unnecessary result more frequently. If unnecessary work steps were performed, they were still performed, but much faster. If unnecessary information were generated, the same information was generated in even greater detail. If workers derailed a process requiring management intervention, they created the same problems more frequently and more profoundly.

Research has shown that work is rarely improved immediately with the introduction of new technologies. In a study of 300 firms, researchers found that failure to change the organization was the largest obstacle in the efficient application of information technology. (Schnitt, 1993, p. 16) Competition and the threat of bankruptcy forced private organizations to modify their operations and undertake radical change. Today "computers are finally being used to change the very nature of work, not just do it faster." (Levinson, 1994, p. 49) The surface Navy should learn from the experiences of these private organizations.

In, "Permanent Whitewater," Vaill described the destiny of organizations that fail to adapt to new technology, capabilities and the changing patterns of work. (Vaill, 1990, pp. 28-29) He assumes free-market competition. The surface Navy will survive, but as the Navy's budget decreases, functions not directly related to combat will increasingly be transferred to better adapted organizations.

LIST OF REFERENCES

American Management Systems, Inc., Shipboard Manpower Analysis, Contract No. N00024-78-C-4103, February 1979

Appelbaum, Eileen and Schettkat, Ronald, *Labor Market Adjustments to Structural Change and Technological Progress*, Praeger Publishers, 1990.

Arnold, Richard R. and Barrie, Robert W., *Analysis of Manning Decisions and Concepts Utilized for the FFG-7 Class Ship*, Thesis, Naval Postgraduate School, Monterey, California, June 1980.

Bissel, Allen M., Oertel, E. James et al, *Shipboard Damage Control*, Annapolis: Naval Institute Press, 1976.

Boorda, Jeremy M., Speech to Students and Faculty of the Naval Postgraduate School, King Hall, 20 July 1994.

Capell, Perri, "Endangered Middle Managers", *American Demographics*, Volume 14 January, 1992.

Department of Defense Military Manpower Statistics, Directorate of Information Operations and Reports, March 31, 1991.

Drucker, Peter F., "The Coming of the New Organization" *Harvard Business Review* Reprint 88105, 1988.

Force 2001: A Program Guide to the U. S. Navy, Department of the Navy Publication, July 1993.

"...From the Sea", Navy and Marine Corps White Paper, Department of the Navy, September 1992.

Gates, Edward T., *Maritime Accidents: What Went Wrong,* Gulf Publishing Company, 1989.

George, James L., "The US Navy FY94 Budget: Treading Water", *Navy International,* Vol. 98 No.7/8, July/August 1993.

Hammer, Michael and Champy, James, *Reengineering the Corporation: A Manifesto for Business Revolution*, Harper Business, 1993.

Information Spectrum, Inc., Final Report Civilian Manning of AE, AFS and AD Type Support Ships Volume 1. 5 April 1983.

Kalleres, Michael P., Vice Admiral, USN, Speech to the Students and Faculty at the Naval Postgraduate School, King Hall, 23 March 1994.

Krafick, J. and J. Womack, "Learning from NUMMI", MIT International Motor Vehicle Project, working paper, 1986.

Leavitt, Harold J. and Thomas L. Whisler, "Management in the 1980s", *Harvard Business Review*, Graduate School of Business Administration, Harvard University, Nov-Dec 1958.

Levinson, Marc, "Thanks. You're Fired. Big Business: Will the Bloodletting on the Job Front Ever End?", Newsweek Inc., The Washington Post Company, May 23, 1994

Minnick, Walter C. "Letters to the Editor", *Harvard Business Review*, November December, 1986.

National Research Council, *Crew Size and Maritime Safety*, Committee on the Effect of Smaller Crews on Maritime Safety, Marine Board Commission on Engineering and Technical Systems, National Academy Press, Washington, D. C., 1990.

National Research Council, *Effective Manning of the U. S. Merchant Fleet,* Committee on Effective Manning, Marine Board, Commission on Engineering and Technical Systems, National Academy Press, Washington, D. C. 1984.

NWP 65-28, CG-52 Class Tactical Manual, 0411-LP-179-3100, Department of the Navy, Office of the Chief of Naval Operations, August 1988.

OPNAVINST 1000.16G Subject: MANUAL OF NAVY TOTAL FORCE MANPOWER POLICIES AND PROCEDURES, 11 June 1990.

OPNAVINST 3120.32B, Subject: SHIP'S ORGANIZATION AND REGULATIONS MANUAL, 26 September 1986.

OPNAVINST 3501.10B Subject: PROJECTED OPERATIONAL ENVIRONMENT (POE) AND REQUIRED OPERATIONAL CAPABILITIES (ROC) FOR THE SACREMENTO (AOE 1) CLASS FAST ATTACK COMBAT SUPPORT SHIP, 5 January 1988.

OPNAVINST 5310.18A Subject: SHIP MANPOWER DOCUMENT/SQUADRON MANPOWER DOCUMENT (SMD/SQMD) DEVELOPMENT AND REVIEW PROCEDURES, 16 April 1986.

OPNAVINST 5311.7 Subject: DETERMINING MANPOWER, PERSONNEL AND TRAINING (MPT) REQUIREMENTS FOR NAVY ACQUISITIONS, 12 August 1985.

Osborne, Joseph W., LCDR, USN, "Who Took the Fun Out of Surface Warfare?", *Surface Warrior*, Issue Number 4, April - May 1994.

O'Shea, Donald, Captain USN (retired) Military Sealift Command Far East. Interview 19 February 1994.

Preisel, J. H. Jr., CDR, USN, "High-tech Below the Main Deck", Proceedings, October, 1988.

Ratan, Suneel, "Staying Strong Without Breaking the Bank", Fortune, February 8, 1993.

Schnitt, David L., "Reengineering the Organization Using Information Technology", *Journal of Systems Management*, Volume 44, No. 1, Issue 379, January 1993.

SECNAVINST 5312.10C Subject: Manpower Planning Systems, 29 October 1974.

Sherwood, John J., *Creating Work Cultures With Competitive Advantage*, Organizational Dynamics, 1988.

Sims, Henry P. and Dean, James W., Jr. "Beyond Quality Circles: Self-Managing Teams", *Personnel*, January 1985.

Skaggs, Jerry, Technical Director, Navy Manpower and Analysis Center, Interviews conducted 6-8 April 1994.

Smith, Elizabeth A., *The Productivity Manual*, Gulf Publishing Company, 1990.

Sovereign, Michael, Professor Operations Research Naval Postgraduate School, Discussion March 1994.

Sperry Marine, *Voyage Management System: Integrated Navigation and Control*, Sperry Marine Inc. JA 60-25-5107.5M, September 1990.

Sprague, Ralph H. and McNurlin, Barbara C., *Information Systems Management in Practice,* third edition, Prentice-Hall, Inc. 1993.

Stewart, Thomas A., "Welcome to the Revolution," *Fortune* 13 December 1993.

Vaill, Peter B., *Managing as a Performing Art*, Jossey-Bass Publishers, 1990.

Walsh, Edward J., "Anzio Pioneers "Real Time" Shipboard Damage Control", *Seapower*, October 1993.

Walters, Brian, "Paperless Bridges", *Navy International*, Volume 98. No. 7/8, July-August 1993.

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